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SEASONAL AND DEPTH DISTRIBUTION OF THE BENTHOS OF LAKE PEARSON, CANTERBURY

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ABSTRACT

Twenty six species were taken from benthic samples in Lake Pearson but almost half (46%) were essentially littoral dwellers which occur commonly in macrophyte beds. The 10 most abundant species occurred at all 8 sampling stations and showed few changes in abundance with depth (7-17 m). The dominant eubenthic species were the oligochaetes *Aulodrilus pleuriseta* and *Limnodrilus hoffmeisteri*, the chironomids *Chironomus zealandicus* and two Macropelopiini species, and a gastropod *Potamopyrgus antipodarum*. Life histories of the common species were imprecisely timed as might be expected for species with wide ecological niches.

KEYWORDS: Lake Pearson, benthos, seasonal variation, depth variation, macrophytes, species richness.

INTRODUCTION

Until the last decade, studies on the benthos of New Zealand lakes were largely anecdotal (see review by Forsyth, 1975). However, in recent years some specific comparisons of benthos have been made between lakes (e.g. Forsyth, 1978; Timms, 1982, 1983) and the biology of common species investigated (e.g. Forsyth & McColl, 1974; Graham

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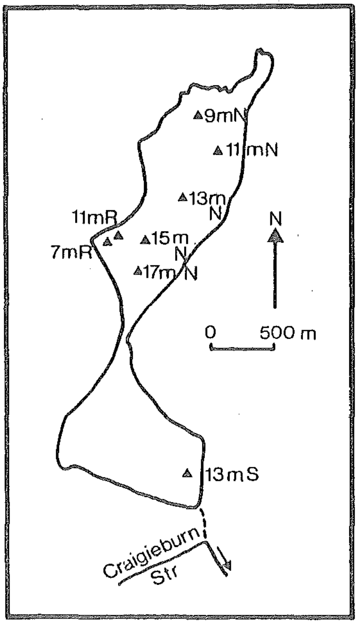

Fig. 1. Lake Pearson showing location of sampling stations.

and Burns, 1983). Forsyth & McCallum (1981) studied seasonal changes in the benthos of Lake Taupo, the approach used in the present study of Lake Pearson.

METHODS AND STUDY SITES

Lake Pearson, is a relatively small (179 ha), shallow lake (maximum depth 17 m) lying at 607 m a.s.l. near Cass in the Canterbury high country. It is generally isothermal and well oxygenated and during the study year (1978-1979) its waters had a temperature range of 4-21 ^{o}C, a nearly neutral pH and an average ionic concentration of 5.0 S/m with Na and HCO_3 ions dominant (Stout 1969, 1975, 1977 and pers. comm.). Flint (1975) and Stout (op. cit.) consider it to be mesotrophic. A dense zone of littoral macrophytes occurs to a depth of about 6-9 m and is composed mainly of Elodea canadensis Michx. and some Myriophyllum propinquum A. Cunn., Potamogeton cheesemanii A.Benn. and Chara spp. Below the macrophyte beds, muds are greyish and firm with little organic matter (ca 11%) (Timms, 1983).

The lake was visited monthly from August 1978 to July 1979. Eight stations were established at the positions shown in Fig. 1 and marked with buoys; 5 formed a series for a depth profile (9 m N to 17 m N), two were located at 7 m and 11 m in the protected

Ritchies Bay (R) and one (13 m S) was situated in the deepest part of the south basin. The two shallowest stations (7 m R, 9 m N) were located very close to macrophyte beds.

At each station 4 replicate samples were collected with a Birge-Ekman grab of 225 cm^2 gape, which penetrated 10-15 cm into the substrate. Samples were sieved through mesh of 0.4 mm and organisms retained were sorted alive and then preserved in 70% alcohol. In the laboratory they were identified and counted. Coefficients of variation for total numbers of animals in replicate samples were usually less than 20% and never greater than 30%. Mean annual numbers per m^2 were calculated by multiplying mean densities for each depth by the area of the lake at the depth interval and integrating (Timms, 1983).

RESULTS

Twenty six species of macroinvertebrates were collected although the average monthly number was 17.8. Species richness varied seasonally from a minimum of 13 in late autumn to a maximum of 21 in summer.

Mean annual abundance of all species at the 8 sampling stations is shown in Table 1. The 10 most common species were taken at all stations; their seasonal and depth distribution patterns are discussed below.

OLIGOCHAETA

Aulodrilus pleuriseta (Tubificidae)
A. pleuriseta was the most common oligochaete found with a mean density of 1632 individuals per m^2. It was most common at intermediate depths (13-15 m). Densities were similar at the two 11 m stations but greater by 1.4X at the northern-most of the two 13 m sites (Table 1). Numbers fluctuated seasonally with a rapid increase from a minimum in October to a maximum in December (Fig. 2a). This probably coincides with a breeding season in late spring followed by a progressive decline in numbers until next spring. Numbers were higher in the 1978 winter (August) than a year later (July 1979).

Limnodrilus hoffmeisteri (Tubificidae)
L. hoffmeisteri was unevenly distributed in the lake with maximum numbers at the shallow stations off the littoral band of macrophytes and greater numbers (about 1.4X) in the north basin than in the south (Table 1). Mean annual density was 250 individuals per m^2. There were two seasonal peaks in numbers, one in mid-spring and the other in mid-autumn (Fig. 2a) possibly resulting from two pulses in breeding activity. Numbers were slightly lower in the second of the two winters.

Lumbriculus variegatus (Lumbriculidae)
L. variegatus was most numerous at stations near littoral macrophytes, and at 13 m in the south basin (Table 1). Seasonal

Table 1. Mean annual abundance (Nos. m^{-2}) of benthic invertebrates at 8 sampling stations in Lake Pearson, August 1978 - July 1979. * = 1 individual found only.

Species	Stations 9mN	11mN	13mN	15mN	17mN	7mR	11mR	13mS	weighted mean (see text)
Turbellaria									
Cura pinguis (Weiss)		*							
Oligochaeta									
Lumbriculus variegatus (Muller)	56	36	14	21	16	30	22	59	25
Limnodrilus hoffmeisteri Claparede	1209	40	72	34	55	598	13	50	250
Aulodrilus pleuriseta (Piquet)	696	1405	1897	2570	1574	1032	1343	1360	1632
Hirudinea									
Glossiphonia multistriata Mason	1	0	0	0	0	3	0	0	1
Odonata									
Procordulia grayi (Selys)	1	0	0	0	0	15	10	0	3
Xanthocnemis zealandica (McLachlan)	0	0	0	0	0	6	2	0	1
Trichoptera									
Oecetis unicolor (McLachlan)	40	62	57	49	30	28	78	44	53
Triplectides cephalotes (Walker)	5	1	0	1	1	29	11	0	5
Paroxyethira hendersoni Mosely	17	1	1	0	0	5	2	1	3
Polyplectropus puerilis (McLachlan)							*		
Lepidoptera									
Nymphula nitens (Butler)	0	0	0	0	0	2	1	0	1
Coleoptera									
Antiporus strigosulus (Broun)						*			
Diptera									
Macropelopiini	755	956	944	690	617	764	815	909	855
Ablabesmyia mala (Hutton)	0	0	1	1	3	3	4	1	1
Chironomus zealandicus Hudson	473	898	451	545	213	401	758	419	529
Chironomus sp."a"	5	2	0	4	0	11	1	5	3
Cladopelma curtivalva (Kieffer)	51	8	3	3	1	137	30	22	28
Cricotopus sp.	7	0	2	1	1	7	3	0	3
Acarina									
Piona uncata exigua Viets	454	13	17	18	20	54	35	13	72
Gastropoda									
Potamopyrgus antipodarum (Gray)	2766	440	221	125	58	1396	199	119	655
Gyraulus corinna (Gray)	11	0	0	0	0	8	1	0	2
Phyastra variabilis (Gray)	51	0	0	0	0	0	0	0	5
Bivalvia									
Sphaerium novaezelandiae Deshayes	36	51	13	14	14	1	17	34	34
Hydridella menziesi (Gray)	0	0	4	1	3	0	1	6	2
H. menziesi shells	0	0	5	135	223	0	5	7	22

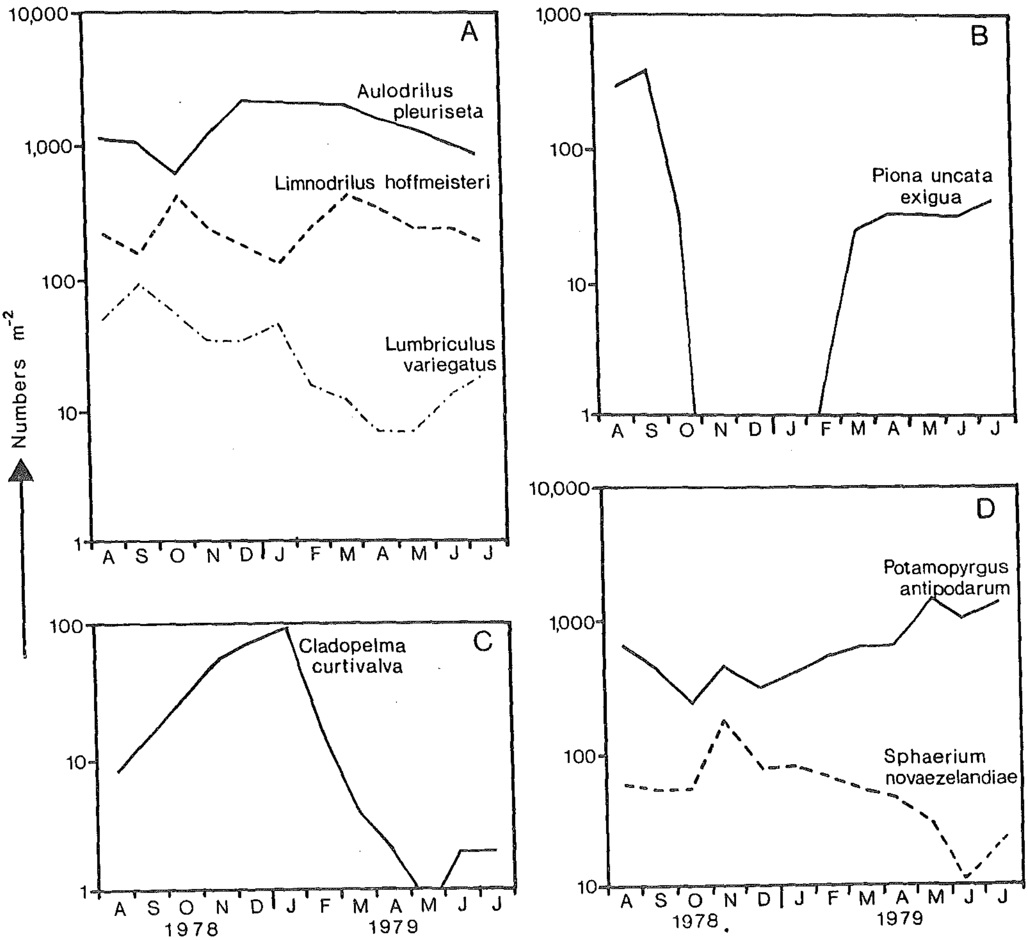

Fig. 2. Seasonal variation in numbers (weighted lake means) of selected macrobenthic species. A, Oligochaeta: Aulodrilus pleuriseta, Limnodrilus hoffmeisteri and Lumbriculus variegatus; B, Acarina: Piona uncata exigua; C, Chironomidae: Cladopelma curtivalva; D, Mollusca: Potamopyrgus antipodarum and Sphaerium novaezelandiae.

fluctuations in numbers (Fig. 2a) suggest that reproduction (which is by splitting in half) was maximal in winter, or even restricted to that time.

TRICHOPTERA

Oecetis unicolor (Leptoceridae)

O. unicolor was the most common and only eubenthic trichopteran with a mean density of 53 individuals per m^2. It was relatively evenly distributed but with lower numbers near macrophytes, at greater depths and in the south basin (Table 1). Seasonal fluctuations in numbers and in the relative abundance of the last three instars (Fig. 3a) suggest most individuals took about a year to develop. Numbers were lower in the second winter.

DIPTERA: CHIRONOMIDAE

Seven species of Chironomidae were recorded in the lake but only three, Gressitius antarcticus (Hudson), Macropelopia umbrosa (Freeman) and Chironomus zelandicus were common.

Macropelopiini
Larvae of the two species of Macropelopiini (G. antarcticus and M. umbrosa) could not be told apart so they are treated together. They were abundant (mean density 855 individuals per m^2) and relatively evenly distributed within the lake (Table 1). Numbers were appreciably lower in the second winter. Life histories did not appear to be well synchronized although relative abundance of 2nd instar larvae was greatest from January to April, suggesting maximal egg hatching in summer and early spring (Fig. 3b). Individuals overwintered as either 2nd, 3rd or (mainly) 4th instars. The emergence period (as indicated by presence of pupae) was long (from at least November to March).

Chironomus zealandicus
C. zealandicus was relatively abundant (mean density 529 individuals per m^2) and distributed in a similar manner to the Macropelopiini. However, its numbers showed more seasonal variation. A distinct pulse of 2nd instar larvae was present from January to March and most individuals overwintered in instar 4. Numbers of larvae were low from October to December when pupation and emergence occurred (Fig. 3c).

Cladopelma curtivalva
This species occurred at all stations but was most abundant near the littoral macrophytes and at the 13 m station in the south basin. Third and 4th instars occurred most abundantly in summer so that emergence and breeding was probably maximal then and soon after (Fig. 2c). Unlike other chironomids in Lake Pearson, most individuals did not seem to overwinter in the 3rd or 4th instars.

ACARINA

Piona uncata exigua (Pionidae)
This mite was found throughout the lake, with maximum numbers near the littoral macrophytes, particularly at the northern end (Table 1). There were marked seasonal fluctuations in numbers with a peak in winter and none at all present during summer (Fig. 2b). These changes accord with Stout's (1977) observations that P. uncata is planktonic during the warmer months, but spends the winter near or on bottom mud. As for many of the other benthic invertebrates, numbers were lower in the second winter.

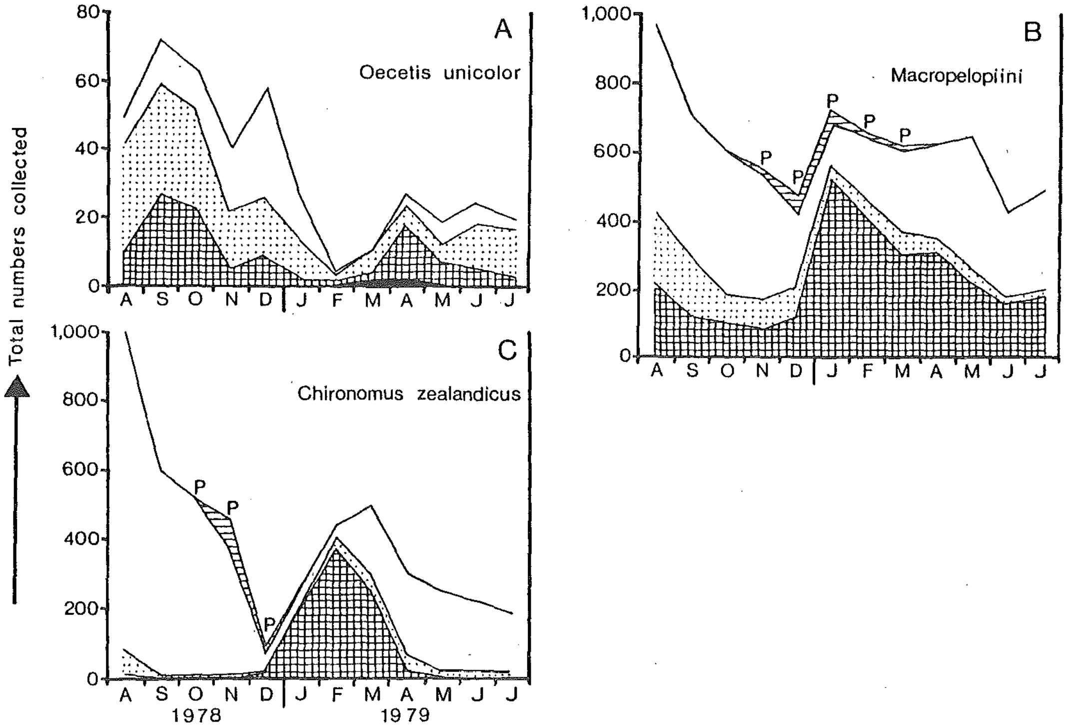

Fig. 3. Seasonal variation in the abundance of life history stages of three insects. A, Oecetis unicolor; B, Macropelopiini; C, Chironomus zealandicus. Unshaded, final instar (F); dotted, F-1; cross hatched, F-2; solid, F-3; horizontal lines, prepupa; P, presence of pupae.

GASTROPODA

Potamopyrgus antipodarum (Hydrobiidae)
P. antipodarum was the most common mollusc in the lake with a mean annual density of 655 individuals per m^2. Most snails were found near the littoral macrophytes and numbers fell steadily with depth. Comparatively low numbers also occurred at 11 m in the south basin (Table 1). Snails were least abundant in spring and most common in late autumn, but in contrast to many insect species numbers were higher in the second winter than the first (Fig. 2d).

DISCUSSION

Species richness of the benthos of Lake Pearson was slightly greater than recorded for other New Zealand lakes (Forsyth 1978;

Forsyth & McCallum 1981; Timms, 1982, 1983) with the exception of Lake Rotoiti (Nelson) where 26 species were also found (Timms, 1980). This high species richness probably results in part from the more intensive study of Lake Pearson. The dominant species (Limnodrilus hoffmeisteri, Macropelopiini species, Chironomus zealandicus and Potamopyrgus antipodarum) were also common in most other New Zealand lakes studied, though it is unusual for Aulodrilus pleuriseta to be so abundant (Forsyth, 1978; Timms 1982, 1983).

Nine of the species recorded in Lake Pearson were taken only at stations close to macrophyte beds and can be regarded as essentially littoral dwellers. They were Cura pinguis, Glossiphonia multistriata, Procordulia grayi, Xanthocnemis zealandica, Polypectropus peurilis, Nymphula nitens, Antiporus strigosulus, Gyraulus corinna and Physastra variabilis all of which are common on littoral macrophytes in nearby Lake Grasmere (Stark, 1981). A further 3 species, Triplectides cephalotes, Paroxyethira hendersoni and Cricotopus sp. also occurred well away from the littoral zone but were common near it. Overall, the influence of littoral species on the composition of benthic fauna was similar to that in other Cass lakes (Timms, 1983) and in the Rotorua lakes (Forsyth, 1978). Although undeniably eubenthic in habitat some other species were most common in areas near macrophytes possibly because greater feeding opportunities occurred there. Species in this category were Limnodrilus hoffmeisteri, Cladopelma curtivalva and Piona uncata exigua, and to a lesser extent, Lumbriculus variegatus and Chironomus sp. a. A significant positive correlation between numbers and amounts of particulate detritus and/or organic matter in the mud was found for one or both oligochaetes in this list in three other Cass lakes (Timms, 1983).

Marked variations in distribution and abundance within Lake Pearson were not expected considering the extent of littoral macrophytes and the relative shallowness of the lake. However, biomass (Timms, 1983) and numbers were almost always greater near the macrophytes and least at the deepest station. No species were limited to the deeper zones of the lake. The differences between the south and north basins reported by Timms (1983) were also observed in this more comprehensive study. It is also interesting to note that for a number of the more common species, densities were greater in August 1978 than in July 1979. Differences in benthos densities between years are not uncommon (e.g. Brinkhurst, 1974) and it is possible that the unusually windy summer of 1978-79 (as indicated by N.Z. Meteorological Service records from the nearby Craigieburn Forest; V.M. Stout, pers. comm.) adversely affected some insect, particularly chironomid, breeding (cf. Jonasson, 1972). Some non-insect species (e.g. mites, sphaeriid clams) were also less abundant in winter 1979, however, so this cannot be the only explanation. Furthermore, the population of Potamopyrgus antipodarum was substantially larger in the second winter.

Limited phenological data available for the more common species indicated that oligochaetes reproduced mainly from late-winter to late-spring (with a secondary autumn peak in *Limnodrilus hoffmeisteri*) whereas insects bred predominantly in summer. The caddisfly, *Oecetis unicolor* and the midge *Cladopelma curtivalva*, appeared to be univoltine but the other common chironomids were at least bivoltine. Graham & Burns (1983) showed that *Chironomus zealandicus* could complete its life cycle in ca 75 days at 18°C and in ca 110 days at 12°C, so that at least in shallow water, one or maybe two shorter summer generations are likely as well as a long overwintering one. Overall, life histories of common species were not strongly synchronized and cohorts were not distinguishable in multivoltine species. Such a condition might be expected where niches are broad as claimed by Timms (1982).

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